Minnesota's Aging Infrastructure

INTRODUCTION & CONTEXT

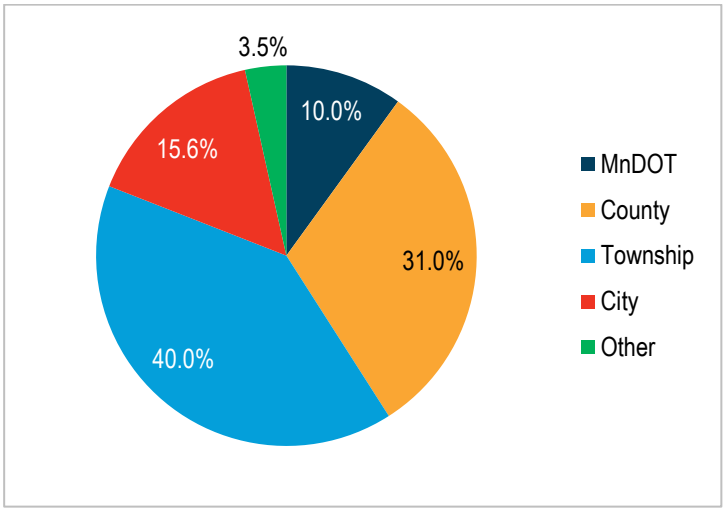
Minnesota's public infrastructure is aging; government entities – from small towns to state agencies – are facing long lists of needed fixes with too few resources to address them. The United States' roads, bridges, water and sewer lines, levees, and other infrastructure components were rapidly constructed to meet the needs of a growing population, resulting in an expansive system that has suffered from a lack of maintenance since it was put into place. According to the American Society of Civil Engineers, the United States will face a cumulative investment gap of $1.1 trillion from 2016 to 2025.[1] The longer maintenance needs go un-addressed, the more costly the maintenance will be. As such, addressing aging infrastructure in the United States and Minnesota must be a high priority.

Minnesota's story is not unlike the rest of the United States. Aging infrastructure, a lack of preventative maintenance, and insufficient replacement of assets in poor condition has resulted in leaky pipes, pothole-ridden streets, and the inefficient delivery of services. This is largely due to many investment needs competing for limited funds. In Minnesota, the average driver spends an estimated $480 per year in extra operations and maintenance costs from driving on roads in need of repair.[2]

While this report focuses mostly on MnDOT's aging transportation infrastructure, it is important to consider infrastructure owned by other government agencies for transportation and non-transportation purposes. Even underground utility systems like water and sewer infrastructure can have impacts on the transportation system if not properly maintained.

Ownership of transportation infrastructure in Minnesota is divided between different government jurisdictions. This can lead to confusion regarding who is responsible for maintenance and what funding sources are available. Figure 1 shows the breakdown of roadway lane-miles in Minnesota by level of government. When appropriate, MnDOT pursues realignments to make sure that Minnesota's roads are owned and operated by the right level of government for the services needed. Jurisdictional transfers between government agencies often involve costly improvements to make sure that roads are in good condition at the time of the transfer but can lead to cost savings and efficiencies in the long run.

Figure 1: Ownership of the roadway system by lane-mile[3]



[1] ASCE, 2016
[2] ASCE, 2017
[3] FHWA Publications Archive, 2015

MINNESOTA'S HIGHWAY SYSTEM

Historical Growth and Ongoing Maintenance

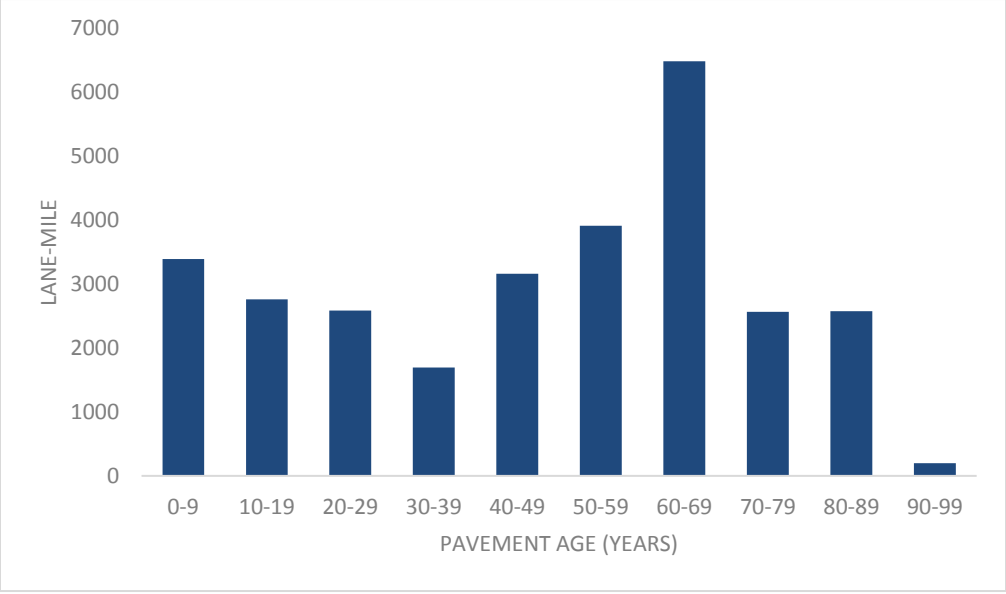
As is the case with many other aging public assets, the era when Minnesota's network of roads and bridges was built has significant impacts on maintenance costs experienced today.

Beginning around 1945, all miles on the state highway system were classified as surfaced, which included everything from improved gravel roads to modern pavements.[4] Today, almost all of the state highway system has been paved, with the exception of 14 lane-miles on Minnesota Highway 74 near Weaver, Minnesota in the southeast part of the state. The majority of gravel highways were paved during the 1950s and 1960s (60 to 70 years ago) which helps explain the magnitude of maintenance and preservation need on the highway system today; the typical life expectancy of a roadway is 40 to 70 years before major repairs are necessary. MnDOT projected the investments necessary to meet the state high transportation needs through 2037 total $39 billion.[5]

Highways

The bulk of Minnesota's pavements were originally constructed between 60 and 70 years ago. The Federal Aid Highway Act of 1956 provided funding for freeways and expressways to be built throughout the country, which is the primary reason for the substantial spike in the number of lane-miles between 40-70 years old. Given the number of highways that were built and rapid system expansion that occurred in the years following, many roadways in the US are now in need of significant maintenance or reconstruction. Generally speaking, roads are fully reconstructed about every 50 years. The age at which a reconstruction is needed varies greatly from roadway to roadway and is due to environmental factors, type of use, traffic levels, use by heavy commercial freight traffic, type of pavement, amount of maintenance received, and more. Figure 3 shows the age of pavements on the state highway system based on the date of their original construction, not when they were most recently resurfaced or overlaid.

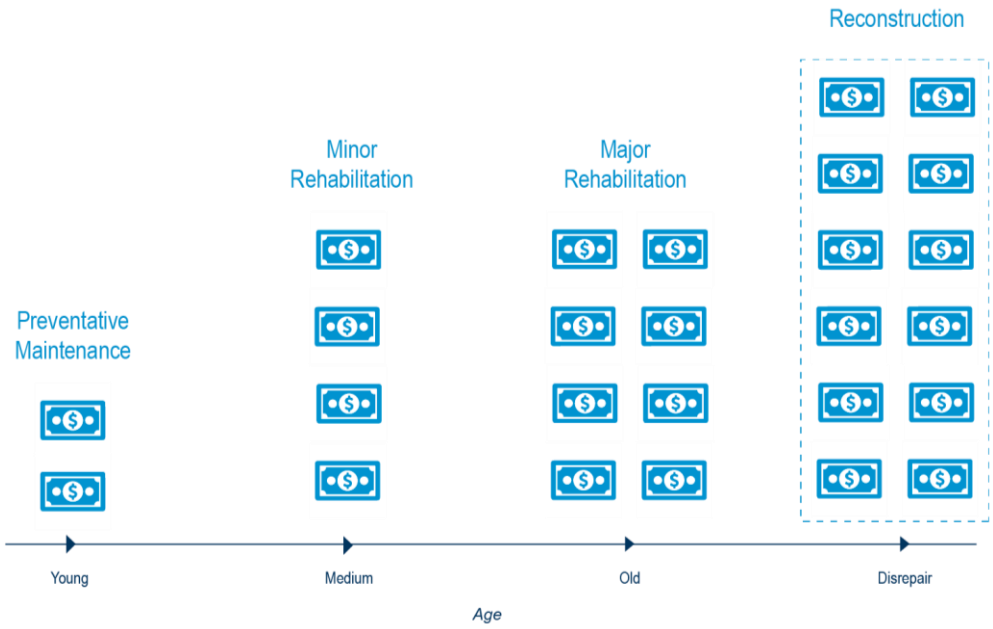
Figure 3: Age of pavement on the State Highway System as of 2017[5]



[4] FHWA Publications Archive, 2015
[5] Minnesota State Highway Investment Plan (2018-2037)
[5] MnDOT Transportation Asset Management, 2017

Preventive maintenance treatments, which can only be applied when the pavement is in good condition, are significantly cheaper than major rehabilitation at poor condition (Figure 4). If best management practices for maintenance are not implemented in a timely manner, future fixes become more expensive as pavement quality decreases and more substantial repairs are needed. MnDOT needs to invest periodically over time before eventually reconstructing the road.

Figure 4: Typical Treatments and Costs for Pavements[6]



Bridges

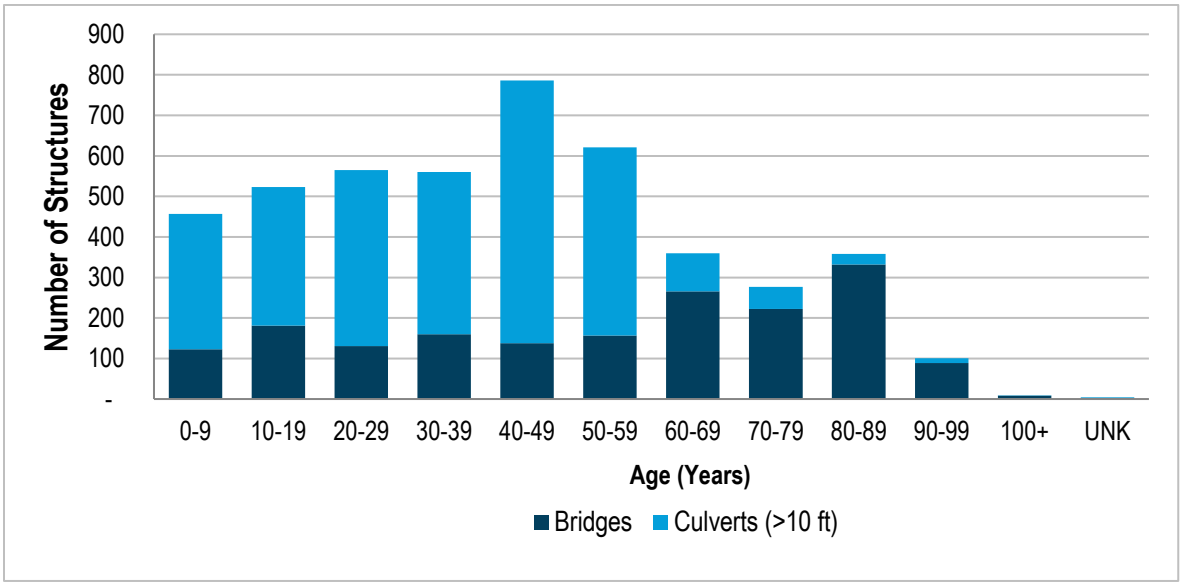
Bridges have historically been constructed with a theoretical design life of 50 years, though newly constructed bridges are expected to remain functional for 75 to 100 years or more due to recent materials and engineering improvements.[7] Timely and proper bridge maintenance during their lifespan is an important step in achieving the full useful life of a structure. If preventative maintenance is skipped, future fixes become more expensive due to deterioration that worsens more quickly if it is allowed to continue.[8] In addition, the buying power of the available transportation funds continue to decline over time. MnDOT estimates that eliminating the backlog of its deficient bridges requires a total investment of $2.65 billion over the next 20 years. Pavement needs total $13.45 billion over the next 20 years. [9]

As of 2016, 8.2 percent of MnDOT's highway structures were functionally obsolete or structurally deficient.[10] Functionally obsolete bridges feature designs that are no longer adequate for their task, including too few lanes to accommodate traffic, no space for emergency shoulders, or drawbridges on a congested highway. A structurally deficient bridge has one or more defects that require attention. They can range from relatively minor issues to severe problems.

[6] MnDOT Transportation Asset Management Plan, 2014
[7] FHWA Bridge Preservation Guide
[8] Ibid.
[9] Minnesota State Highway Investment Plan, 2017
[10] MnDOT, 2016

Accounting for these pressing needs often takes up resources that could otherwise be used to maintain sound bridges that are in need of minor – preventative maintenance. This can result in the establishment of a "worst-first" maintenance strategy that is more expensive to carry out in the long term. Figure 5 shows the age of bridges and culverts on the state highway system.[11]

Figure 5: Age of bridges and culverts (greater than 10 feet in length) on the state highway system[12]



LOCAL INFRASTRUCTURE

Local units of government are often responsible for maintaining their public infrastructure systems, including streets, bridges, water systems, and more. Over half of local governments in Minnesota practice some form of asset management to operate, maintain and extend the life of their infrastructure.[13] Most larger cities and counties engage in asset management practices or planning.[14] In a recent study, each level of government viewed their effectiveness differently. Large cities and counties saw their current efforts as being the most effective, while small cities viewed it as less effective.[15] Asset management is especially important for local units of government because funding for infrastructure often comes from property tax receipts. Maintenance can be a significant issue for towns with struggling tax bases.

There are a variety of ways to facilitate asset management activities, including mapping and database establishment. Airports, roads and water supply and distribution pipes are most commonly documented through mapping applications.[16] This is perhaps unsurprising given the important role that asset mapping plays in society for wayfinding purposes. Buildings, ports, traffic fixtures and fleet were consistently the least frequently mapped assets across local units of government.[17] Tracking asset location and quality allows local governments to develop estimates of the total value of assets, though few local municipalities have completed value assessments.

A 2015/2016 study found that the majority of local entities do not know the value of their assets.[13] 529 out of 2,744 relevant jurisdictions across Minnesota responded to MN2050 state of infrastructure survey in 2015/2016. Of those, 22 percent of large cities reported the value of road assets, which was the highest response rate for all asset types. Much further research is needed to understand the total value of local, publicly-owned assets in the state.

[11] MnDOT Bridge Office, 2015. Note: there are more than 47,000 culverts that are less than 10 feet in length on the state system. Age information is not available for these culverts.
[12] MnDOT Bridge Office
[13] MN 2050 State of Infrastructure Report, 2016
[14] Ibid.
[15] Ibid.
[16] Ibid.
[17] Ibid.

Case Study: Duluth-Superior Metropolitan Interstate Council

The Duluth-Superior Metropolitan Interstate Council included a focus on asset management strategies in their update of the Connections 2040 Long-Range Transportation Plan. Based on data collected from roadway stewards in the region, the MIC found that 49 percent of pavements were good quality, while 24 percent were fair and 27 percent were poor.[18] On the whole, the region has improved pavement condition from 2009 levels by engaging in sound asset management practices. Most poor condition pavements are on the local and county roadways.[19] Continued maintenance of the local bridge network will be critically important – MIC research found that 63 percent of bridges and 76 percent of bridge miles in the region are between 25 and 50 years old and are likely to require increasingly larger maintenance investments.[20]

AIRPORTS

MnDOT's State Aviation System Plan includes an overview of estimated maintenance costs at Minnesota's airports, broken into common funding categories. Infrastructure needs at airports include building maintenance, taxiways and property management challenges. In total, Minnesota's public airports, not including MSP International, had a projected maintenance bill of $2.46 billion between 2012 and 2030, 40.3 percent of which was for general improvements.[21] Projected funding levels for Minnesota's public airports do not come close to meeting this level of need. Funding for airports from 2012 to 2030 is anticipated to top out at $855 million or one-third of the total improvements needed for all public airports besides MSP.[22] The Metropolitan Airport Commission 2030 Long Term Comprehensive Plan estimated that MSP International alone would require $2.4 billion in facility improvements[23].

RAILROADS

Minnesota's railroads, while not owned by the state, also contribute to the growing body of aging infrastructure that requires maintenance. Typically, the state is responsible for maintaining the safety equipment at railroad-highway at-grade crossings. In total there are more than 1,400 active rail crossing warning devices in operation across the state – 270 of these (21 percent) are more than 30 years old. The typical design life for a crossing warning system is between 20 and 25 years.[24] Public awareness about the importance of crossing infrastructure has increased in recent years, given high-profile incidents involving trains that carry crude oil from North Dakota's Bakken oil fields. These incidents are discussed in further detail in the paper on Minnesota's Freight Rail system. A study of at-grade crossings along the rail routes used to ship Bakken crude revealed $244 million in needed maintenance and improvements to improve safety for trains and those crossing the tracks.[25]

PORTS & WATERWAYS

Minnesota's ports and commercial waterways face a similar plight as other components of the transportation system – a large list of sorely needed maintenance work and limited funding. Commercial waterways in Minnesota are used extensively to ship bulk goods to and from the state. MnDOT offers support to public ports through the Port Development Assistance Program. The four ports (out of nine) in Minnesota who most recently sought funds from the PDAP had project needs in excess of $34 million, while $5 million in state funds were distributed in 2018.[26] Dredging needed to maintain predictable shipping passageways for barges and ships are one of the key expenses on Minnesota's waterways. The US Army Corp of Engineers spent $9.3 million for dredging on the Saint Paul District's section of the Mississippi River in 2012, and $5 million in Minnesota's Lake Superior ports.[27] Maintaining locks and dams is also critically important. While the Corp spent $9.2 million in 2012 on lock and dam maintenance,

[18] Duluth-Superior Metropolitan Interstate Council, 2014
[19] Ibid.
[20] Ibid.
[21] MnDOT State Aviation System Plan, 2013
[22] Ibid
[23] Metropolitan Airports Commission, 2010
[24] MnDOT State Rail Plan, 2015
[25] Ibid.
[26] MnDOT Statewide Ports & Waterways Plan, 2014
[27] Ibid.

there is a total need of more than $110 million on the St. Paul District's lock and damn system (which includes Minneapolis through Guttenberg, IA).[28]

OTHER INFRASTRUCTURE

Other infrastructure systems like water delivery and sewer face similar issues to transportation infrastructure. Given that many local roadway systems rely on general revenue sources like property taxes, these systems often must compete for limited funding. Additionally, they are frequently co-located with transportation infrastructure. Finding ways to coordinate maintenance activities on transportation, water and sewer infrastructure systems is key to minimizing disruptions and maximizing efficiencies.

Water Delivery Systems

Public assets in need of maintenance extend beyond only transportation infrastructure. Investment needs for buried drinking water infrastructure across the country for the next 25 years total more than $1 trillion.[29] The lifespan of water pipes tends to be longer than most transportation assets, though the importance of preventative maintenance at appropriate times remains important. Maintaining consistent preventative maintenance schedules is a challenge, considering that systems across the United States experience 240,000 water main breaks each year.[30] Pipes built in the late 19th and early 20th centuries are just now reaching the point where they need to be replaced.[31] Public water utilities often run into funding challenges due to seemingly plentiful supplies of drinking water in the United States. Funding maintenance activities is difficult as water rates have been held at levels that do not accurately depict the true cost of treating and delivering water to the public.[32] A combined strategy of rate hikes for water service and creative financing solutions will be needed to address maintenance needs.

WASTEWATER SYSTEMS

Minnesota's wastewater infrastructure consists of pipes, pumps, treatment plants, buildings and grounds, and land for disposal. Requirements under the Clean Water Act have led to new investment in pipes, plants and equipment to eliminate the occurrence of combined sewer overflow events. As a result, the number of people provided with advanced wastewater treatment at national level increased dramatically from 7.8 million in 1972 to 127.7 million in 2012.[33] In Minnesota, wastewater systems have been improved significantly in the past decade. The state's documented needs declined from $4.6 billion in 2008 to $2.3 billion in 2012.[34]

STORMWATER SYSTEMS

Early sewers in Minnesota built in the 1800s were combined, carrying both stormwater and sanitary sewage directly to Mississippi River. Today, much of Minnesota's stormwater infrastructure is over 100 years old. A 1987 amendment to the Federal Clean Water Act required implementation of comprehensive national program to address polluted stormwater runoff. Maintaining stormwater systems is important for making sure that the state's structures and transportation assets are safe. Climate change will likely increase the amount, frequency and intensity of precipitation, potentially exceeding the design capacity of stormwater infrastructure in Minnesota. State agencies and municipalities have a growing obligation to manage their aging infrastructure with limited budget and resources. The estimated cost of replacing stormwater system in the City of Minneapolis alone is $713 million. [35] The City of Minneapolis models the storm drainage system to help prioritize capital improvement projects to upgrade the system over time.

[28] Ibid.
[29] American Water Works Association
[30] American Society of Civil Engineers
[31] American Water Works Association
[32] American Society of Civil Engineers
[33] Ibid.
[34] Environmental Protection Agency, 2012
[35] EPA Case Study

RELATED TRENDS

- Freight Rail in Minnesota
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- Dynamic Road Pricing
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